Agreement between NO_2 passive samplers and urban monitoring stations

Samantha Sartori[1], Cristian Pattaro[1], Marta Rava[1], Roberto Bono[2] and Roberto de Marco[1]

[1]Division of Epidemiology & Medical Statistics, University of Verona
[2]Department of public health and microbiology, University of Turin

BACKGROUND

The interest of environmental epidemiology on air pollution and health, requires reliable data on individual exposure to pollutants.
The measurements from one or more monitoring stations (MSs) may not represent the exposure of the whole population.

AIMS OF THE STUDY

Our focus was on two objectives:

- to verify the ability of the environmental MSs to give a reliable estimation of the amount of pollution to which a subject, living in that town, is truly exposed
- to evaluate the best summary statistics to be used, when multiple and different MSs are being used in the same city, for the assessment of individual exposure.

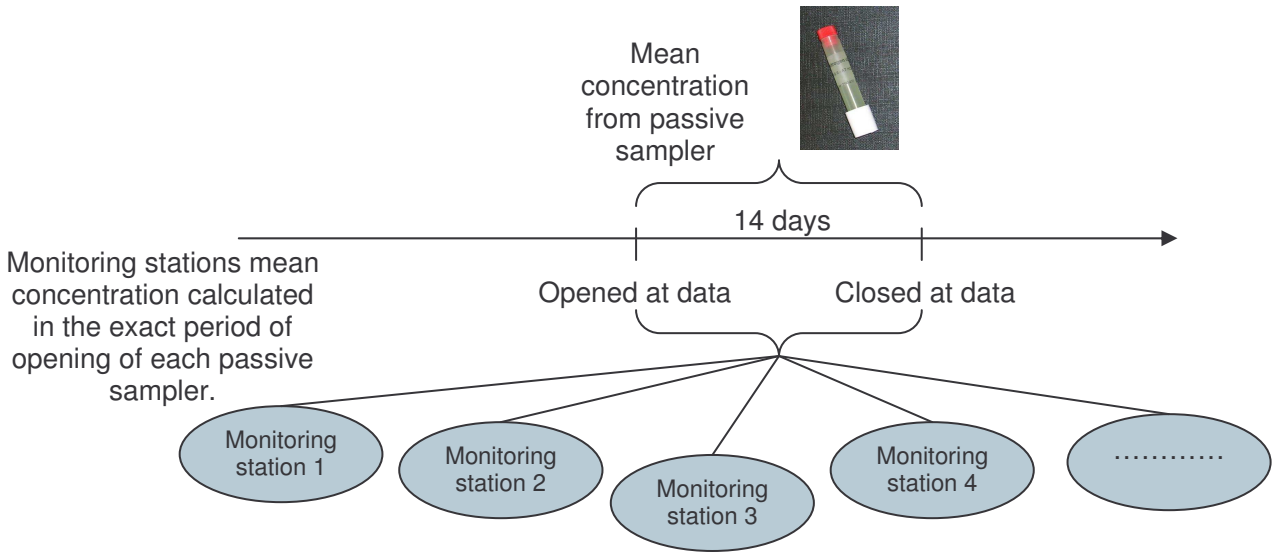
In the present study we considered the situation where a measure of global NO_2 exposure for an area of interest is needed and data from a number of monitoring stations placed in the area are available. The crucial question is whether the use of all the available information coming from the whole set of MSs (combined by some function, e.g. mean, median, max, etc.) is better than the use of the measurement coming from a single "representative" MS. Single and combined measurements have been evaluated and compared.

MATERIALS AND METHODS

The study is part of the survey ECRHS-II NO_2 indoor, which took place in the years 2001-2003, with the aim of evaluating the exposure to NO_2 in a domestic environment.
The 227 participants in this study were part of random samples of the adult population of the two cities.
The protocol provided for the collocation of a passive NO_2 sampler outside the kitchen window of the house where the subjects lived. Samplers collected NO_2 over a period of 14 days. The chemical arrangement of the sampler made it possible to measure the average exposure over the period.
To control for the seasonal effect, two measurements were taken for each individual, usually six months apart (we labelled the two measurement as Phase I and Phase II).
NO_2 time series from several MSs placed throughout the towns involved have been produced by the local Agency for the Protection of the Environment (ARPA).In order to study the ability of MSs to represent the exposure, values of individual NO_2 have been compared with the values registered by the MSs during the corresponding opening period.

Centre/MSs	Types of MSs	
	Type	Description
Verona		
Torricelle	BS	**Background** MS placed in a **Suburban** area
P.zza Bernardi	BU	**Background** MS placed in an **Urban** area
S. Giacomo	TU	**Traffic** MS placed in an **Urban** area
C. Milano	TU	**Traffic** MS placed in an **Urban** area
Cason	BR	**Background** MS placed in a **Rural** area
ZAI	TU	**Traffic** MS placed in an **Urban** area
Torino		
Rivoli	TU	**Traffic** MS placed in an **Urban** area
Rebaudengo	TU	**Traffic** MS placed in an **Urban** area
Lingotto	BU	**Background** MS placed in an **Urban** area
Gaidano	TS	**Traffic** MS placed in a **Suburban** area
Cristina	TU	**Traffic** MS placed in an **Urban** area

The comparison is between the mean concentration recorded from each monitoring station in the same period when each passive sampler was open.



The agreement between the mean concentration measured from the MSs and the concentration measured from the individual samplers assessed through the Pearson's coefficient of correlation and the coefficient of concordance (CCC; Lin 1989)

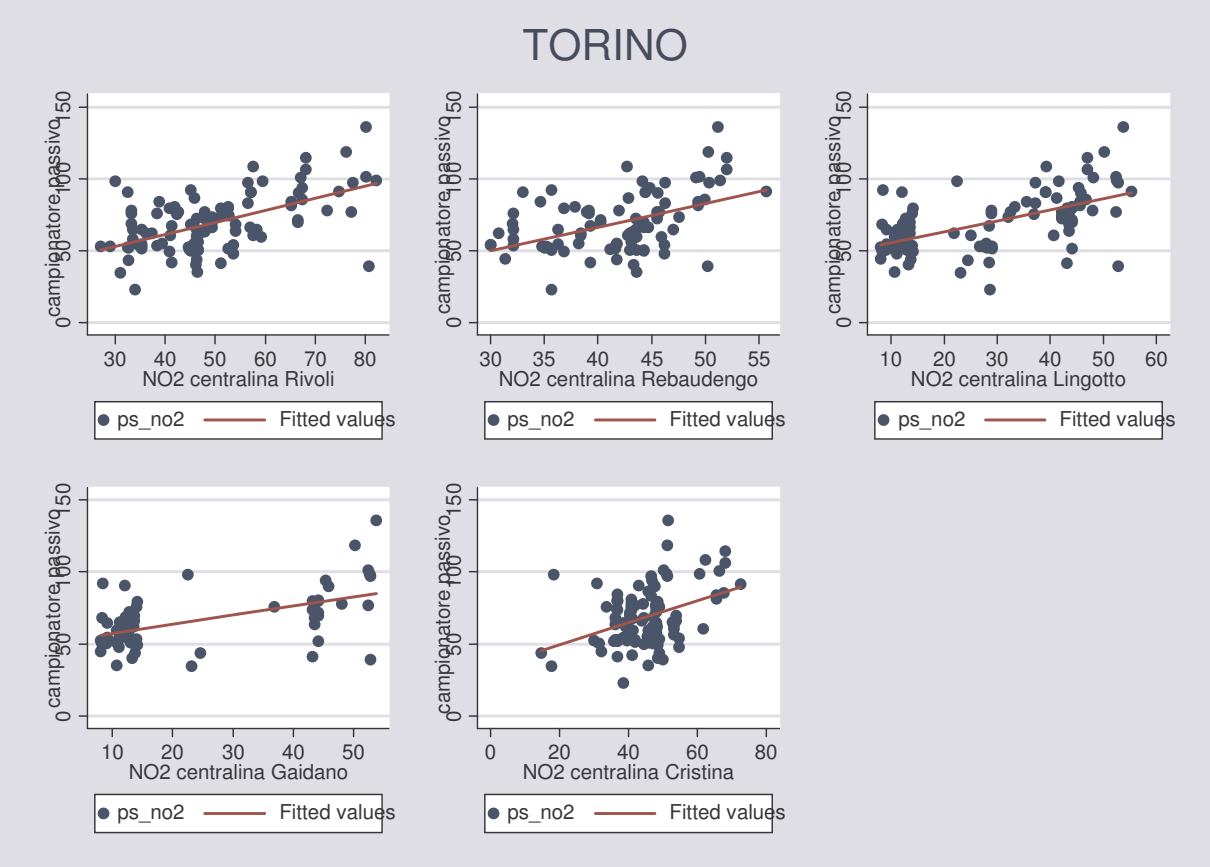
RESULTS

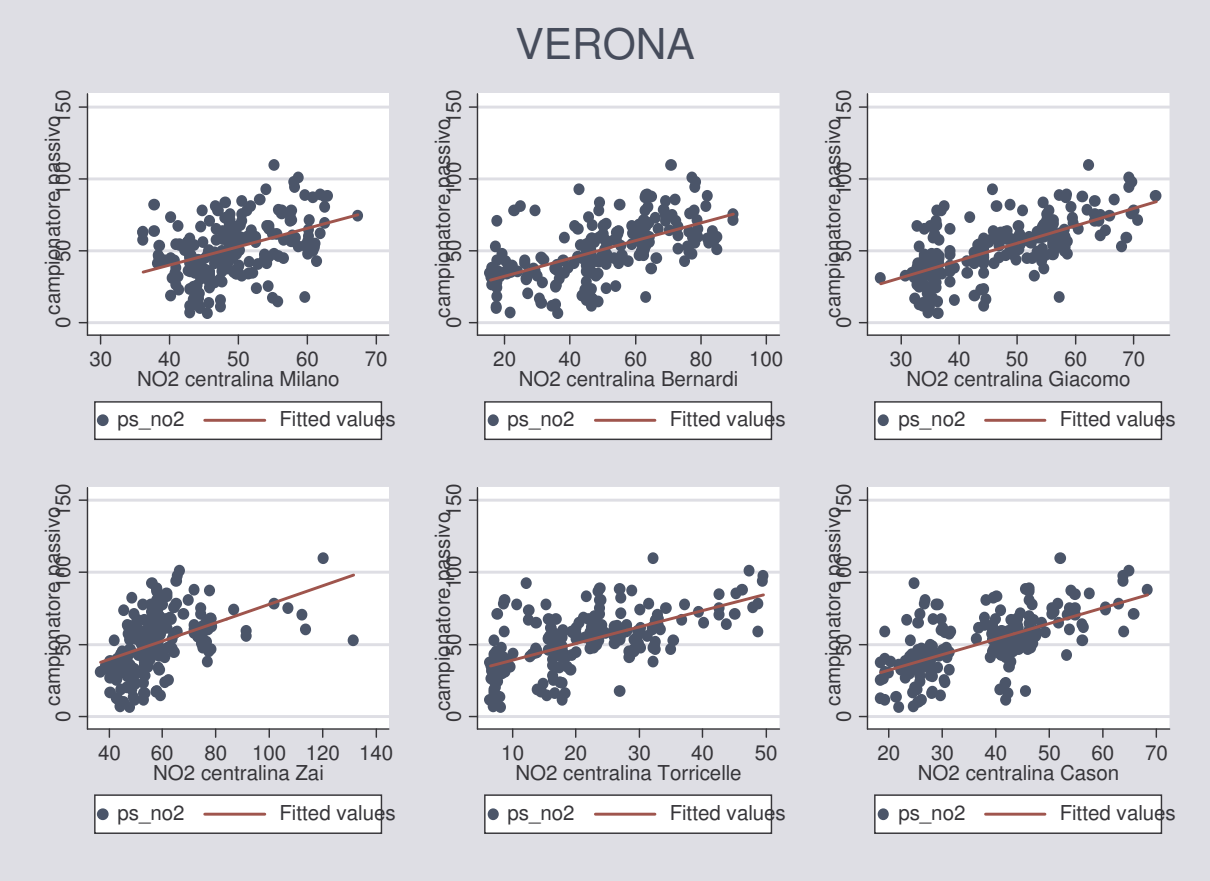
The correlation between the MSs and passive samplers is similar in the 2 areas and is not lower than the best correlated MS.

When considering the pollution levels recorded in the individual samplers, Torino showed higher levels than Verona (respectively 69.0 vs 51.4, $p<0.001$); an opposite result has been observed when the values at the MSs were considered (38.9 vs 43.9, $p<0.001$).

Centre/MSs	Type of MSs	NO_2 mean concentration measured from the MSs for each subject in the PSs opened period.				Correlations and Concordance between PSs and MSs	
		Oss.	NO_2 mean	NO_2 sd	NO_2 range	Corr	CCC
Verona (Phase I e II)							
Torricelle	BS	222	20.6	10.8	6.5-49.5	.64	.18
P.zza Bernardi	BU	222	50.8	18.5	15.6-89.8	.58	.58
S. Giacomo	TU	222	46.6	10.7	26.5-73.9	.66	.53
C. Milano	TU	222	49.0	6.3	36.2-67.3	.41	.24
Cason	BR	222	37.7	11.2	18.5-68.4	.62	.39
ZAI	TU	220	58.5	14.0	36.8-131.5	.46	.40
Media Verona		222	43.9	10.2	26.1-71.0	.66	.49
Torino (Phase I)							
Rivoli	TU	103	49.3	13.4	27-82.2	.56	.31
Rebaudengo	TU	92	41.8	5.8	30-55.7	.48	.09
Lingotto	BU	105	27.9	15.2	8-55.3	.58	.15
Gaidano	TS	68	23.6	16.4	8-53.7	.54	.14
Cristina	TU	105	45.5	10.0	14.7-72.5	.38	.14
Media Torino		105	38.9	10.3	19.9-64.6	.64	.19

The Figures below show the combined trend of the concentrations measured by the samplers and the mean registered in the open period of each sampler by the MSs.





The correlation and the concordance between the MSs data and those measured by passive samplers are reported in the Table according to the type of MS and area. It can be noted how the concordance changes among the areas.

Centre	Traffic		Background		Best monitoring station*		**MSs Average**	
	Corr 95% C.I.	CCC 95% C.I.	Corr 95% C.I.	CCC 95% C.I.	Corr 95% C.I.	CCC 95% C.I.	**Corr 95% C.I.**	**CCC 95% C.I.**
Verona (nr.=222) 3 traffic 3 background	.61 [.52-.69]	.46 [.39-.53]	.64 [.56-.72]	.41 [.35-.49]	.66 [.58-.73] **Urban-Traffic**	0.58 [.50-.67] **Urban-Background**	**.66 [.58-.73]**	**.49 [.42-.56]**
Torino (nr.=104) 4 traffic 1 background	.63 [.49-.73]	.20 [.14-.26]	.58 [.43-.69]	.15 [.10-.21]	.58 [.43-.69] **Urban-Background**	.31 [.21-.41] **Urban-Traffic**	**.64 [.51-.74]**	**.19 [.13-.25]**

* We define the best MS, as the one with the best correlate with the PS (column Corr), or the one with the best concordance (column CCC).

DISCUSSION

In the present study, we considered the situation where a measure of global NO_2 exposure for an area of interest is needed, and data from a number of monitoring stations placed in the area are available.

The use of a "representative MS" is certainly an appealing way of dealing with the problem, but the notion of representativeness and validity of the choice are rarely discussed and taken into consideration.

The assignment of an exposure level to an area implies the choice of what type of data should be used. The choice can be easy if the monitoring net is based on a fine grid. Unfortunately, this is not common, and MSs are often located in only a few selected sites.

This study originates from the necessity of verify the ability of MSs to provide a global estimation of the pollutant and the impact of different methodological paths that can be followed.

If the aim is not that of the estimation of the pollution in defined areas of the town, but rather to assign an exposure to the whole area during a given period of time, the use of the information provided by the whole set of MSs seems to be the right choice.

CONCLUSION

The study shows that the mean of all the MSs is correlated to the measurement of the passive samplers with the same strength of the best monitoring station of the centre. Therefore, if the aim is to assign an exposure level to the area without any information regarding the MSs or the structure of the monitoring net of the centre, the information coming from the entire set of MSs appears the best choice.

Bibliography

- Bland JM, Altman DG. Measuring agreement in method comparison studies. Statistica Methods in Medical Research 1999; 8: 135-60.
- Bland JM Altman DG. Statistical Methods for assessing agreement between two methods of clinical measurement. Lancet 1986; i: 307-310.
- de Marco R at all. for the ISAYA study group. The impact of climate and traffic-related NO_2 on the prevalence of asthma and allergic rhinitis in Italy. Clin Exp Allergy 2002; 32(10): 1405-12.
- European Community Respiratory Health Survey II Steering Committee. The European Community Respiratory Health Survey II. Eur Respir J. 2002 Nov;20(5):1071-9.
- Laurence I-Kuei Lin. A Concordance Coefficient to Evaluate Reproducibility. Biometrics, Vol.45, No. 1 (Mar., 1989), 255-268.
- Laurence I-Kuei Lin. Assay Validation Using the Concordance Correlation Coefficient. Biometrics, Vol.48, No. 2 (Jun., 1992), 599-604.